

Abundance of Marine Debris Estimated from Hawai'i Longline Observer Data

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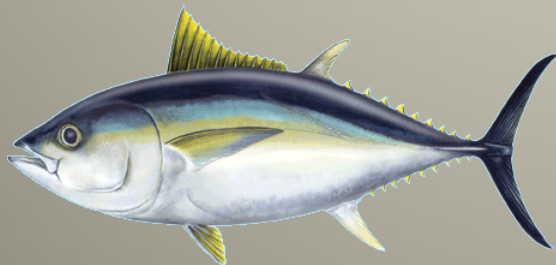
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Hawai'i-based Pelagic Longline Fishery

Deep Sector

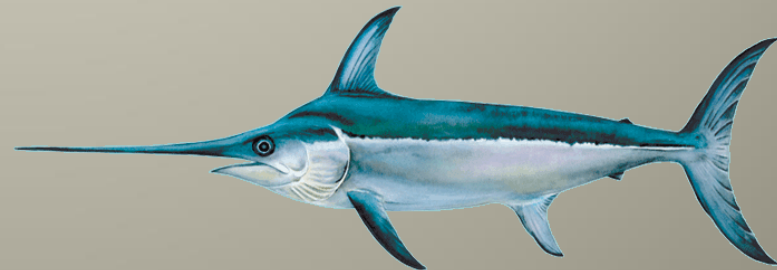
- Bigeye tuna
- 2400 hooks per set
- 243m depth
- 20 hour soak
- Below 30°N
- Deploy after dawn
- Annual



Thunnus obesus

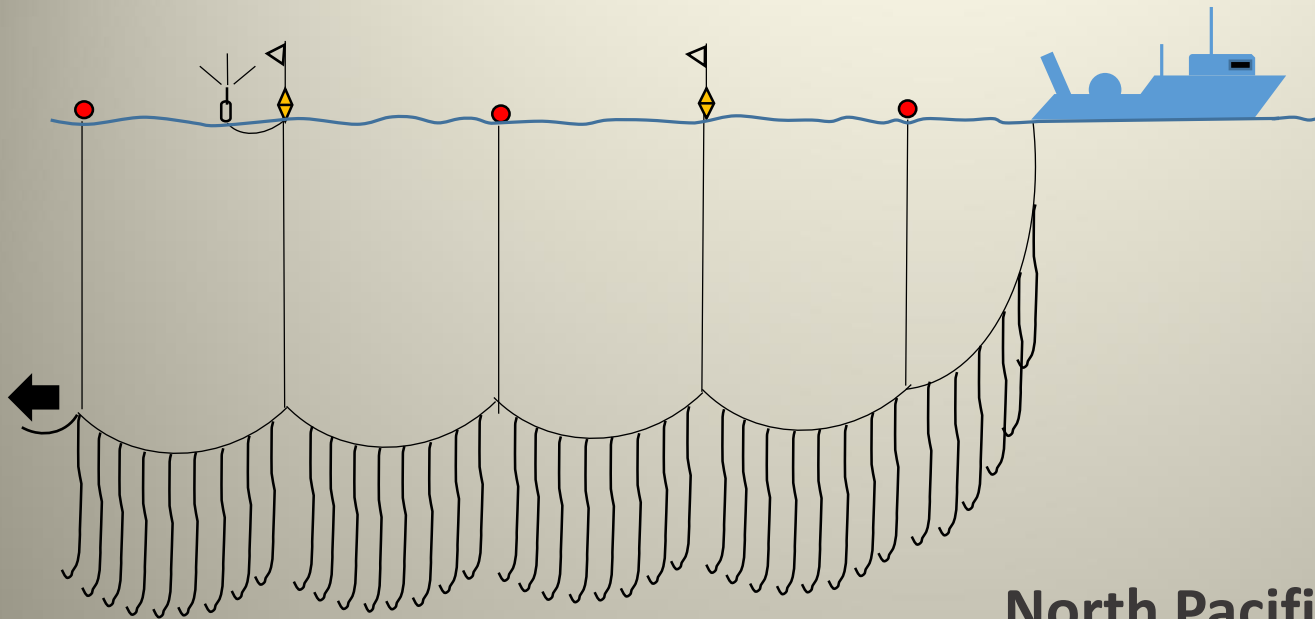
Shallow Sector

- Swordfish
- 1000 hooks per set
- 64m depth
- 20 hour soak
- Above 30°N
- Deploy at sunset
- Winter

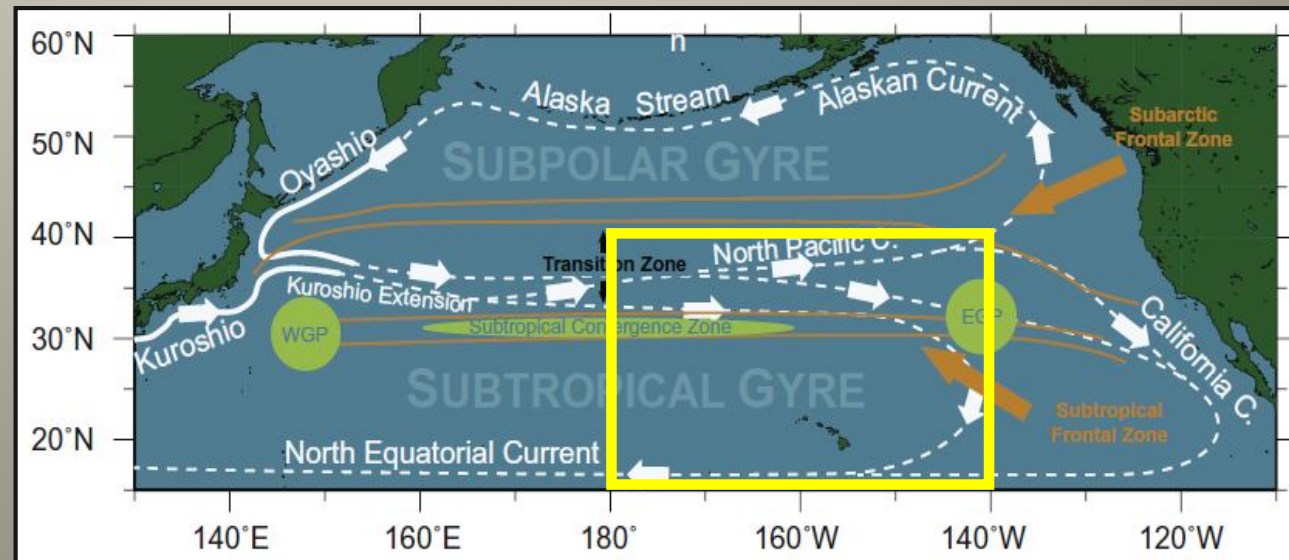


Xiphias gladius

Hawai'i-based Pelagic Longline Fishery



North Pacific Ocean



Hawai'i-based Pelagic Longline Fishery



NOAA Pacific Islands Region Observer Program

- Onboard longline observations initiated 1994
 - priority focus on longline gear and protected species interactions
 - shallow sector: 100% coverage; deep sector: 20%
- Marine debris longline observations initiated late 2007
 - report interactions with longline gear, vessel, species, at surface



Objective

- To estimate marine debris abundance using GLM to standardize CPUE as previously used for bycatch and incidental catch



Data Collection 2008-2016

- Counts of marine debris per set
 1. net
 2. rope/line
 3. monofilament
 4. metal
 5. cloth
 6. plastic sheeting/tarp
 7. floats buoys
 8. FAD
 9. other
 10. lumber
 11. natural

NOAA Pacific Islands Regional Office, Observer Program

Marine Debris Encounter Report

This information is being used to help determine the economic cost of marine debris impacts to fisheries.

Trip Number: _____

Position of Encounter with Debris (includes vessel, gear and animals)

Latitude: ___° ___' N / S Longitude: ___° ___' E / W (positions to nearest whole minute)

Date: _____ Time: _____

Incident Type:

Gear Interaction Noteworthy Sightings (e.g., large collection of small debris items, large debris objects, etc.)

Vessel Interaction

Entangled Species Caught (e.g. entangled swordfish) Other (includes recovered ingested debris items): _____

Debris Type:

Net Cloth

Rope Plastic sheeting

Monofilament line Floats

Metal (describe): _____ FAD (Fish Aggregating Device)

Other (describe): _____

Biota Type (on or living in net) – List species names if known:

Fish _____

Crustaceans _____

Encrusting organisms _____

Description of incident type and debris object/material: (describe the type of incident in more detail, diameter or width, length, colors and biota living on the debris)

Weight: (est.) ___ lbs Photos: Y / N Debris brought on board? Y / N

Length of downtime: _____ hrs

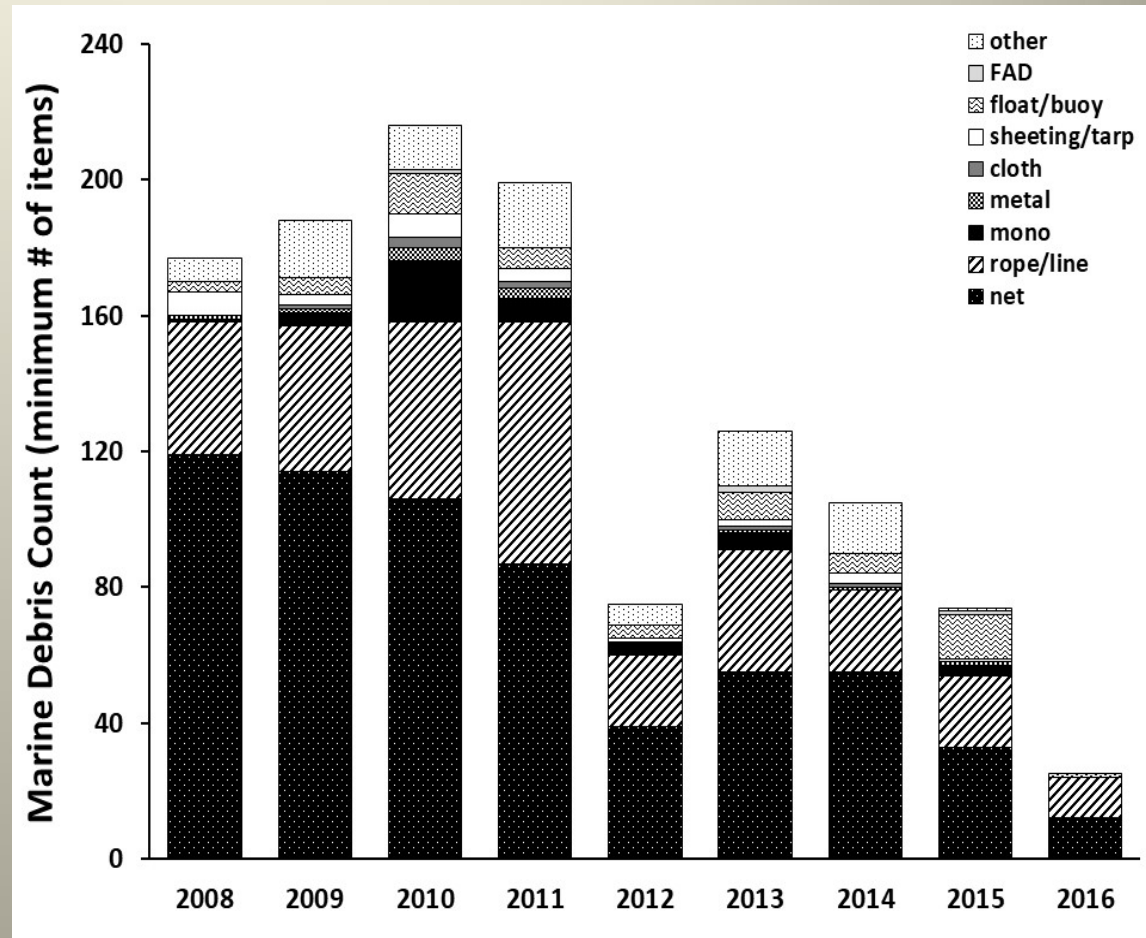
Description of downtime and cost (describe what was done during downtime (e.g. propeller disentangled by divers) and details of cost):

Generalized Linear Model to Standardize CPUE

- Zero-inflated negative binomial model
 - overdispersed count data
 - extra zeros from reporting error or survey error (or both)
 - 2 components: positive counts & probability of extra zeros
 - offset = number of hooks per set
- Predictor variables
 - year (2008-2016)
 - quarter (1st – 4th)
 - sector (shallow, deep)
 - observer type (high, low)
 - convergence zone (in, out)
 - begin-set latitude
 - begin-set longitude
 - fishing region (6)
 - total catch
 - soak duration
- Sampling unit = individual longline set (N = 40,572)
 - # sets deep: 32,130
 - # sets shallow: 8,442

How Much & What Type

- 858 sets with debris
 - 418 deep
 - 440 shallow
- 1326 total items
 - 51.8% net
 - 26.7% rope, line
- 1.2 - 1.6 items per set
 - min: 1
 - max: 9



Model Selection

Parameter	df	AIC	Δ AIC	Δ AIC/df	Median residual	k
<i>Negative binomial count model - positive counts</i>						
Intercept	1	10439.22	.	.	-0.1162	0.1912
Year	8	10328.39	110.82	13.85	-0.1140	0.0215
Quarter	3	10218.97	109.42	36.47	-0.1183	0.1527
Sector	1	9628.69	590.28	590.28	-0.1174	0.0414
Latitude	1	9293.10	335.60	335.60	-0.1145	0.0529
<i>Logistic model for zero inflation - odds of extra zeros</i>						
Longitude	1	9206.19	86.91	86.91	-0.1118	0.1498
Convergence zone	1	9184.95	21.24	21.24	-0.1130	0.1824
Observer	1	8819.69	365.26	365.26	-0.0966	0.5098
Sector	1	8786.13	33.56	33.56	-0.0925	0.8377

Neg binomial count model: expected positive counts per set

- Increasing debris through 2011, decreasing thereafter
- Less debris in Q3 (July - September)
- Less debris in deep sector (40.5% ↓ *in positive counts*)
- More debris moving north (12% ↑ *in positive counts for 1° ↑ in latitude*)

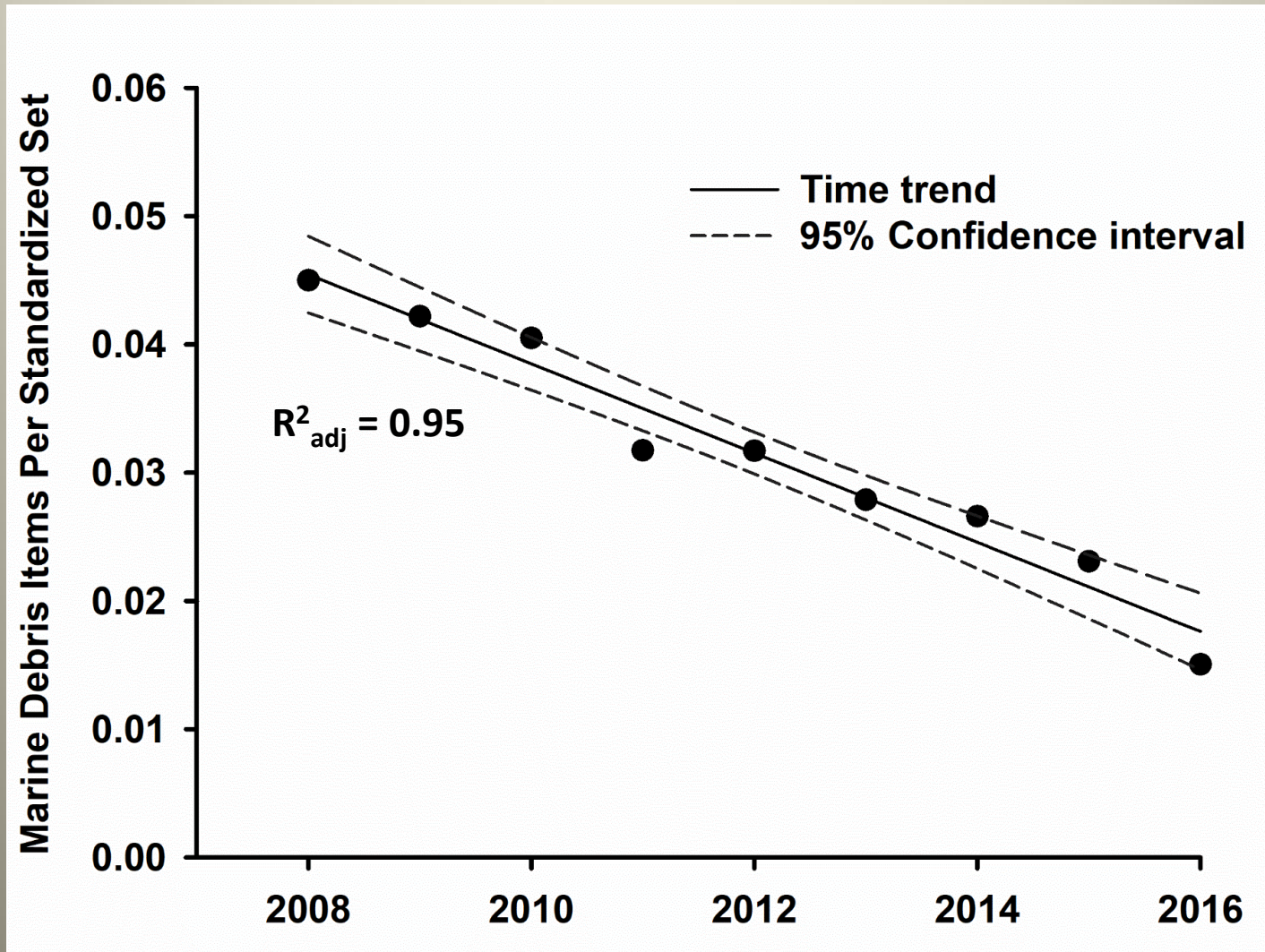


Logistic zero-inflation model: odds of zero counts per set

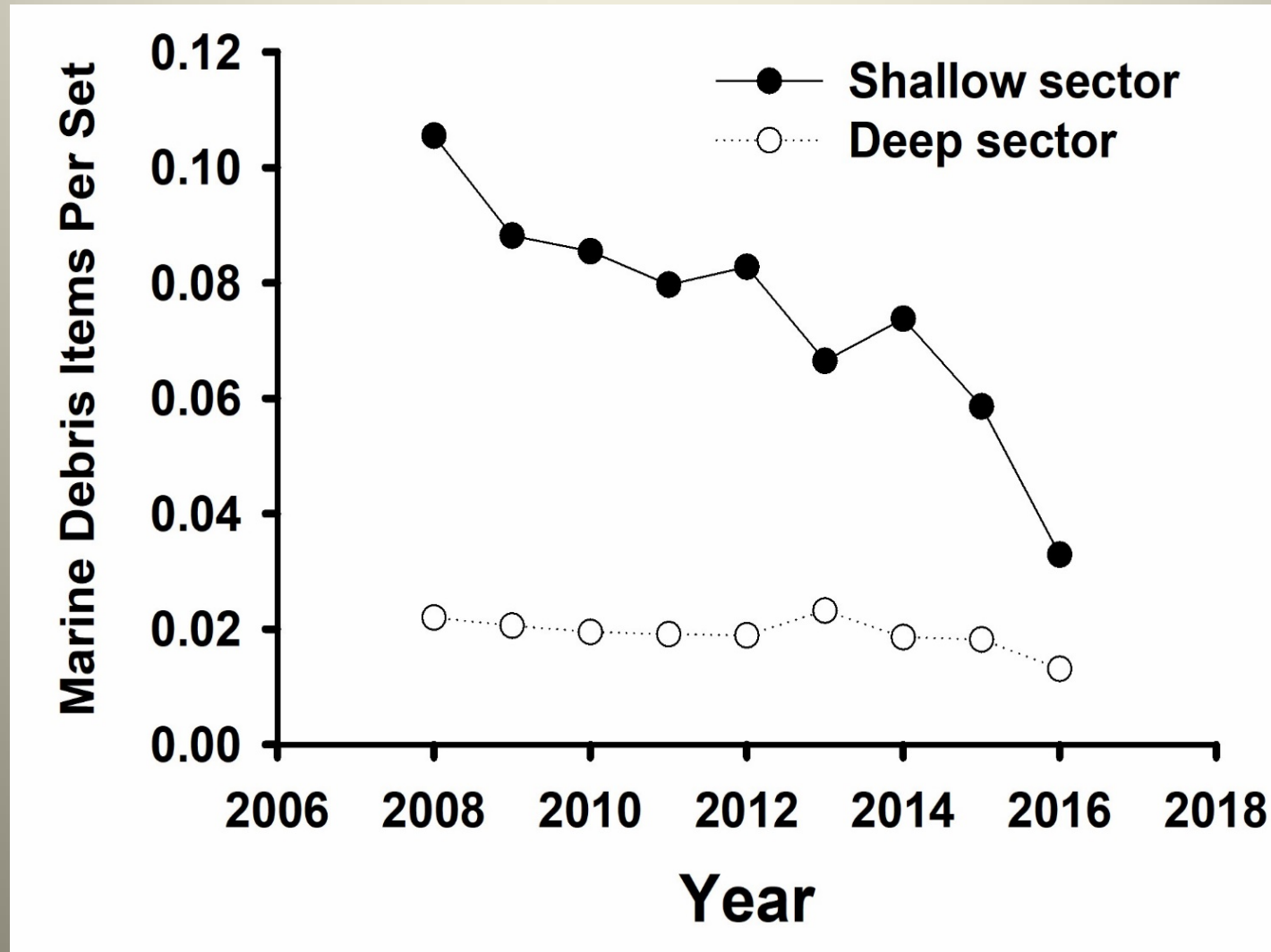
- More debris moving east (5% ↓ *in odds* for 1° ↓ *in longitude*)
- More debris inside convergence zone (56% ↓ *in odds*)
- More debris reported by experienced observers (79% ↓ *in odds*)
- Less debris in deep sector (127% ↑ *in odds*)



Annual Standardized CPUE



Annual Standardized CPUE By Sector



Key Findings

- Prevalence of derelict nets in STCZ & moving towards EPGP
 - consistent with model trajectories of surface drifters
- Debris likely snagged close to the surface
 - nets composed of buoyant polymers
 - net bundles float with some draft
- More debris in shallow sector despite less effort
 - overlap with surface & depth distribution of debris
 - target shallow sector for observations & removal
- Steady decline in marine debris over time
 - global moratorium on large-scale pelagic driftnets
 - organized removal from nearshore
 - some removal by fishermen
 - post-tsunami fleet reduction